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Effective Teaching Modalities in Nurse Anesthesia Pharmacology

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EFFECTIVE TEACHING MODALITIES IN NURSE ANESTHESIA PHARMACOLOGY

by

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ABSTRACT

Student Registered Nurse Anesthetists entering the clinical setting must be able to recall and apply pharmacological principles learned through Nurse Anesthesia Pharmacology classes. To ensure students are prepared to perform in high-pressure environments such as the clinical setting and in stressful situations, students must have a firm pharmacological background. To determine the most effective teaching modality for nurse anesthesia pharmacology, an extensive literature review was conducted exploring pharmacological principles, high-pressure performance, the stress of new students in clinical health professions, and adult pedagogy.

A survey was created based on the survey disseminated by The University of Southern Mississippi to the 2018 Nurse Anesthesia Program Cohort who were taught nurse anesthesia pharmacology courses utilizing a video-only format. The 2020 Nurse Anesthesia Cohort who were taught nurse anesthesia pharmacology utilizing video instruction with supplemental instruction and simulation were then surveyed. The data was collected and both surveys were analyzed for common themes and differences. From this data and an extensive literature review, a best practice recommendation was created.

The data from the surveys along with the literature review and the best practice recommendation was presented to a panel of experts. Data from the panel members was gathered anonymously using The University of Southern Mississippi's Qualtrics website assessing the panel member's opinions on if the suggestions would be effective in teaching nurse anesthesia pharmacology, would prepare student registered nurse anesthetists for the clinical setting, if the information was of high quality, and if the proposed recommendation would benefit the Nurse Anesthesia Program.

ACKNOWLEDGMENTS

We would like to show our deepest gratitude to our committee chair, Dr. Mary Jane Collins, for her guidance, patience, and encouragement in helping us complete our project. We would also like to acknowledge our committee member, Dr. Nina Mclain for her support and guidance throughout this process.

DEDICATION

We would like to dedicate this paper to our spouses who have encouraged us throughout the completion of this project. Without the love and support of them and our families, this paper may not have been possible.

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LIST OF ABBREVIATIONS

AANA	American Association of Nurse Anesthetists
CRNAs	Certified Registered Nurse Anesthetists
DNP	Doctor of Nursing Practice
IRB	Institutional Review Board
NAP	Nurse Anesthesia Program
OR	Operating Room
SRNAs	Student Registered Nurse
USM	The University of Southern Mississippi

CHAPTER I – INTRODUCTION

When student registered nurse anesthetists (SRNAs) enter the clinical setting, clinical instructors and preceptors expect students to arrive prepared to recall and apply pharmacological concepts learned through their didactic coursework (Nurse Anesthesia Program, 2019). Through this challenge, a question is raised: What is the most effective way to teach pharmacology to SRNAs so that knowledge can be effectively translated into clinical practice? One challenge of nurse anesthesia education is relaying information so SRNAs are taught how to take their learning beyond test-taking and into implementing their knowledge of pharmacology. This process is necessary so SRNAs can safely anesthetize patients in a timely manner and under tense circumstances.

Problem Description

Recall and application of pharmacological concepts are difficult in high-pressure, real-world settings for nurse anesthesia students new to clinical practice (Crouzevialle, Smeding, & Butera, 2015). The SRNA's inability to recall and apply pharmacological information in the clinical setting has the potential to negatively impact patient safety and student performance. Incorrect actions made by the SRNA toward patients undergoing surgical procedures can result in harm to patients in the preoperative, intraoperative, and postoperative periods, as well as after patients return either to a hospital room or to their own homes (Dhawan, Tewari, Sehgal, & Sinha, 2017). The cause of patient safety violation could be the result of medication errors, adverse drug events, or from failure to treat which is all attributed to human error (Dhawan et al., 2017). Additionally, the result could be dismissal from the clinical day with the possibility of probation if the student is unable to intervene when indicated and, thus, perform the appropriate action in a given

clinical scenario. The cause of negatively impacting student performance could be linked to extreme stress in the clinical environment (McKay, Buen, Bohan, & Maye, 2010). A review of best practices was performed to ascertain the most effective teaching platforms for nurse anesthesia pharmacology. Based on literary evidence and results from student surveys within The University of Southern Mississippi (USM) Nurse Anesthesia Program (NAP), a best practice recommendation was developed, presented to a panel of experts for feedback, and finally proposed to the USM NAP faculty for consideration.

Available Knowledge

Admission into USM NAP

Each January doctoral candidates enter the USM NAP. The students enrolled in this program strive toward completing the requirements to obtain a Doctor of Nursing Practice (DNP). DNP NAP students at USM are registered nurses who were working full time in an intensive care unit for a minimum of one year (preferably two) prior to admission (Nurse Anesthesia Program, 2019). Once SRNAs are accepted into a nurse anesthesia program, they are taught how to become anesthesia providers through a combination of didactic coursework and clinical training. The first year of the USM NAP is reserved exclusively for didactic learning. The USM NAP students take classes where they attend lecture, read and study independently, and take tests to measure their learning. The anesthesia classes USM NAP students take during their first year of the program teach the candidates the anatomy, physiology, and pharmacology necessary to deliver a safe anesthetic to the patients they encounter once they enter the clinical setting. The NAP students have a basic understanding of these physiology and pharmacologic concepts prior to entering the program, but the depth of knowledge the students must

understand and be able to apply in the healthcare setting within the span of a year is a tremendous amount of new information. In addition to the abundance of new information the anesthesia students digest during their first year, they also take face-to-face and online doctoral classes where the students read assignments, write papers, and discuss the meaning of being a leader in the field of anesthesia (DNP Essentials Task Force, 2006). The January following entering the NAP at USM, students enter the clinical setting. Upon entering the clinical setting, students are expected to perform appropriate anesthesia machine checks, thorough patient assessments, and a basic anesthetic plan for the patient undergoing surgery. For the student to develop an appropriate anesthetic plan for the patient, the student must utilize their new knowledge of physiology and pharmacology.

Cultivating the DNP SRNA

The purpose of the DNP degree, as the degree relates to anesthesia, is to teach students how to approach the discipline of anesthesia by evaluating research and translating findings into clinical practice (DNP Task Force, 2006). The clinical practice of anesthesia is taught to SRNAs by clinical preceptors in the operating room. The clinical preceptors are both certified registered nurse anesthetists (CRNAs) and anesthesiologists. At USM, SRNAs enter clinical practice at the beginning of their second year of training. SRNAs must be involved in a minimum of 600 cases where they deliver anesthetics to patients with a variety of co-morbidities undergoing surgical procedures ("Standards for accreditation of nurse anesthesia programs," 2018).

The focus of a NAP is to train the CRNAs of the future to safely, effectively and efficiently deliver anesthesia to patients. An abundance of knowledge is required to

successfully accomplish this endeavor. In the clinical setting, SRNAs ought to have a thorough understanding of the medications taken by patients as well as the medications they administer to patients for them to train to become a competent CRNA. However, many SRNAs report a lack of confidence in their application of pharmacology as they enter the clinical setting at the beginning of their second year of anesthesia training. Through advanced pharmacology coursework, SRNAs learn an abundance of new pharmacology information. Students must be able to understand and apply their newly acquired knowledge of pharmacology in the clinical setting (M.J. Collins, personal communication, September 10, 2018). A lack of confidence in applying knowledge of pharmacology in the clinical setting suggests the possibility the NAP may not be teaching pharmacology to SRNAs utilizing the most effective modalities (M.J. Collins, personal communication, September 10, 2018).

Pharmacological Concepts Important to Anesthesia

Dr. John J. Nagelhout defined pharmacology in his text, *Nurse Anesthesia,* as "the study of processes by which a drug produces one or more measured physiologic responses" (Nagelhout, 2014a, p. 53). The definition of pharmacology has remained constant throughout time; however, the understanding and knowledge of the meaning continue to develop and change. In recent years, the study of pharmacology harps on the premise that protein receptors are the primary processes that produce desired pharmacologic responses. Other processes, secondary to protein receptors, affecting the pharmacologic response are drug absorption, distribution, biotransformation, and excretion (Nagelhout, 2014a, p. 53).

Important pharmacological concepts the SRNA must understand as they enter the clinical setting include dosages, pharmacodynamics, and pharmacokinetics. Dr. Nagelhout provides a drug parameter guide the SRNA is responsible for in the clinical practice setting. The suggested drug parameter guidelines for the SRNA include: classification, history, structure activity relationships, pharmacokinetics, preparations and dosages, pharmacology including mechanism of action and dose-effect relationships, the effects of drugs on physiologic compartments, obstetric and pediatric uses, toxicity, treatment of adverse reactions, and clinical experience and current anesthetic uses (Nagelhout, 2014a). Stoelting and Hillier devote many chapters in their book, *Pharmacology and Physiology in Anesthetic Practice,* to the same principles Dr. Nagelhout lists such as the pharmacokinetics and pharmacodynamics of injected and inhaled drugs and the different types of drug classes the provider must have knowledge of to deliver a safe anesthetic (Hillier & Stoelting, 2006).

When determining drug dosing, the therapeutic or desired response must be considered. Most drug calculations are weight-based and calculated per kilogram or body surface area from a predetermined dose for standard populations. This method is used to ensure adequate dosing for patients and prevent adverse side effects from underdosing and overdosing. These methods can be applied to different routes of medication delivery, but the SRNA has the advantage of most commonly using the intravenous method of administering medications in the anesthesia setting. With this route, drug onsets and offsets are accelerated compared to other routes of administration (Nagelhout, 2014a, p. 56).

Another important fact to consider when determining drug dosages is the patient population. The SRNA must understand population and genetic profile of each patient can have significant effects on the dose needed. SRNAs will be expected to provide treatment to patient populations such as pediatric, neonatal, geriatric, and patients with chronic diseases. Within each of these populations the weight, metabolic rate, pathologic state, cardiac profile, and genetic profile will all affect the amount of drug needed for a therapeutic response. Anesthetists must recognize the variability of inpatient care to prevent adverse outcomes from improper drug dosing (Nagelhout, 2014a, p. 55).

Along with dosing, SRNAs must consider many other pertinent facts affecting medication dosing and administration. The first thing to consider is pharmacodynamics which is defined as the drugs mechanism of action and the effects the drug has on the body. The mechanism of action is associated with drug receptors and how the drug administered attaches to the desired receptors. Drug receptors which are composed of proteins can be located extracellular (on the outside of the cell) or intracellular (on the inside of the cell). In addition to the receptor sites, SRNAs must learn what occurs once the drug attaches to the receptor site associated with the mechanism of action (Nagelhout, 2014a, p. 53). Drugs can attach to receptors and act as agonist or antagonist. An agonist activates the receptor the drug binds to and an antagonist inhibits the receptor the drug binds to (Nagelhout, 2014a, p. 54).

"Pharmacokinetics is a term used to describe the study of the changes in the concentration of a drug during the processes of absorption, distribution, metabolism or biotransformation (Eshkevari & Jasinski, 2014, p. 62)." Once a drug has been administered, SRNAs should be able to predict what type of response the drug will have

on the body. All drugs administered are distributed in the body by the vascular system regardless they are administered orally or intravenously. Therefore, the movement and distribution of drugs throughout the body are directly related to the blood level concentration. Once in the blood, the drug can then be distributed to the desired target area. Common receptor target areas for drug administration are organs, muscles, fat, and the central nervous system. Certain properties have major effects on the delivery of drugs such as molecular size, degree of ionization, lipid solubility, and protein binding. Drug administration is often more than just a single dose. Pharmacokinetics assists with the knowledge to understand the needed serum concentrations to produce therapeutic effects without adverse side effects occurring and this is often achieved by multiple dosing (Eshkevari & Jasinski, 2014, p. 62).

Pharmacokinetics must also be understood and mastered in inhalational anesthetics. Inhalation anesthetics are administered to patients to prevent recall and blunt the sympathetic response to surgery. Inhalation anesthetics are provided as a liquid and converted to a vaporizer through the anesthesia machine. Once the anesthetic gas is delivered to the patient, the anesthetic concentration accumulates in the lungs, enters the bloodstream, and is delivered to the brain. The anesthetic concentration delivered is measured via alveolar concentration (lung concentration). The alveolar concentration is equivalent to concentration in the brain. The primary components affecting the delivery of the anesthetic gas are the absorption of the inhalational anesthetic, ventilation, uptake into the blood, cardiac output, the solubility of the anesthetic drug in the blood, and the alveola-to-venous blood partial pressure difference. Secondary factors affecting the

anesthetic gas concentration are the concentration and the second gas effects (Nagelhout, 2014b, p. 78).

Identification of necessary pharmacological principles is important to this project for the anesthesia provider to be successful in the clinical setting and to provide a safe anesthetic to patients undergoing surgical procedures. Authors, Eshkevari, Hillier, Jasinski, Stoelting, and Nagelhout, agree on the areas of pharmacology the anesthesia provider must know and be prepared for when in the clinical setting.

High-Pressure Performance

High-pressure performance can be associated with many different life events. The last-minute of a tied basketball game, the final question leading to a huge cash prize, a test determining the passing or failure of a class, or an airline pilot taking off and landing an airplane are all examples of times when exceptional performance is prepared for and expected. The previously listed events require a person to perform at their best under high intensity. The "choking under pressure" phenomenon was conceived to help understand these situations and how people are likely to respond. Hypotheses associated with the phenomenon are individuals with higher ability than others are most likely to have a subpar performance under pressure (Wang & Shah, 2013).

In the clinical setting, SRNAs must perform in a high-pressure environment. In some circumstances, the clinical environment may be calm with little performance pressure; however, the SRNA must always be prepared for any situation that may occur. The SRNA must be able to actively recall medications and dosages when needed. Studies have shown the students' desire for success and academic excellence contributes to the high-pressure environment created in the clinical setting (Crouzevialle, Smeding, &

Butera, 2015). The high academic and clinical achievement has shown to be associated with the student's record of success (Crouzevialle et al., 2015).

The operating room can have emergent situations similar to the emergency department. These situations can be described as complex with doubt of what consequences may occur. Like the emergency room, the operating room can be full of unpredictable events requiring different levels of the decision-making process. Many components are involved the clinical decision-making when the provider is under high-pressure. Five components which commonly emerge during the decision-making process are "organizational systems, workload, time pressure, individual human factors, and case complexity" (Zavala, Day, Plummer, & Bamford-Wade, 2017). High-pressure settings where critical thinking is applied requires all of these factors to interconnect. Each component can affect the provider's ability to respond efficiently in an emergent or high-pressure environment. The understanding and creation of pathways for appropriate and effective clinical decision-making are of utmost importance for the provider in the clinical setting. The safety of patients and the success of the provider relies on this understanding (Zavala et al., 2017)

Before entering the clinical setting, SRNAs need a foundation of the events that can occur in the operating room. While learning and understanding the general flow of the anesthetic is important, the SRNA must also be prepared for high-pressure states associated with the maintenance of an adverse event. Unfortunately, preparation for high-pressure states only occurs once in the operating room. One option to prepare students for this foundation is clinical pharmacology simulation.

The Stress of New Students in Clinical Health Professions

As SRNAs enter clinical training, their objective is to master the necessary skills to be considered a competent CRNA upon graduation of their program. In order to do this, students must complete over 600 anesthetic cases in which they treat patients of all different ages with varying degrees of pre-existing and/or emergent disease processes ("Standards for accreditation of nurse anesthesia programs," 2018). However, many second-year SRNAs report a lack of confidence in performing pharmacologic interventions towards patients using their newly acquired knowledge of pharmacology as they enter the clinical setting.

NAPs across the country are currently transitioning to a DNP curriculum for nurse anesthetist training, a shift from the master's degree that was the previous requirement, determined by the Council on Accreditation of Nurse Anesthesia Educational Programs. This transformation requires SRNAs to take courses that train them to obtain and implement the skills they need to become leaders in their profession by evaluating research and translating the information into clinical practice (DNP Essentials Task Force, 2006). Nurse anesthesia education is often stressful for DNP NAP students as they work through doctoral coursework, which trains the students to approach the discipline of anesthesia through a scholarship by striving to advance the field through evidence-based practice (DNP Essentials Task Force, 2006). Related to the difficulty of the NAP comes some of the health factors that SRNAs face throughout their time in the DNP NAP.

Stress in the setting of learning is fundamental to the progressive motivation of students. However, stress that extends beyond a moderate level can lead to negative consequences (McKay et al., 2010). A 2011 researcher, Savtchouk, revealed that even a

small experience with acute stress can adversely affect the health of the student (McKay et al., 2010). Acute stress can affect the processing of information by the cerebellum (McKay et al., 2010). The cerebellum plays a large role in motor learning, learning that requires practice, as well as thinking and memory (Leopold, 2016). Three different stressors that directly affect nurse anesthesia students: academic, consisting of the stress associated with coursework and examinations; clinical, the stress experienced by students when they are trying to safely administer anesthetics to patients under the pressure of a preceptor; and external, which encompasses the stressors of everyday life, such as the stress of managing finances as a full-time student (Chipas et al., 2012). These stressors, added together at increasing levels, produce the risk factors for the SRNA to have an unfavorable experience with stress. Stress exists on a sliding scale. At one end of the scale, a student under stress may produce a favorable experience, supporting focus, and at the other end of the scale, the student may have a detrimental response, as previously mentioned (McKay et al., 2010). “When stress reaches a harmful level, it can lead to forgetfulness, preoccupation, depression, headaches, fatigue, & diarrhea…” (Chipas et al., 2012, p. S50).

Anxiety is often the behavioral reaction to stress, another health factor that affects SRNAs (McKay et al., 2010). Anxiety can be described as a hostile inner emotional state that hosts feelings of fear and apprehension that result from the perception of a threatening situation (McKay et al., 2010). Chronic anxiety can negatively affect the formation of memories and the behavioral effect that results from anxiety can hinder motor performance (McKay et al., 2010).

A third health factor to be considered for SRNAs is depression. Depression is an incapacitating disorder that can disturb the functioning of SRNAs (Chipas et al., 2012). "Depression is one of the most common psychiatric disorders affecting university students, with current prevalence rates estimated at 10%.may be due, in part, to the myriad stressors confronting students (eg, financial concerns, academic performance, and relationship issues…depressive symptoms in students can compromise learning and memory processes, adversely affecting academic performance, are associated with problem drinking and suicidal ideation," (Chipas et al., 2012, p. S54). Minimizing stress in the lives of SRNAs is important when they are administering anesthetics to patients because additional stress on top of the high-stress situation of maintaining the patient's airway, hemodynamic status, comfort, and safety can lead to poor performance (McKay et al., 2010).

Adult Education (Pedagogy)

The methodology in which the NAP curriculum is formatted and presented plays a role critical to the success of SRNAs because students are expected to learn a vast amount of pertinent information to perform a safe anesthetic within a short time frame. As students take in new knowledge, they are expected to not only know the information but to understand the content well enough to implement their new knowledge as the material relates to the patient undergoing surgery. This best practice recommendation project seeks to explore, through both literature review and SRNA survey, what the best methods for teaching advanced pharmacology to SRNAs are. The purpose of this project is to gain an understanding of what the best way to teach anesthesia pharmacology to

SRNAs is, so they are able to implement their knowledge of pharmacology in real-time while in the clinical setting.

In 1956, Benjamin Bloom, along with Max Englehart, Edward Furst, Walter Hill, and David Krathwohl developed and published a model for categorizing educational progression that is referred to as Bloom's Taxonomy (Anderson, Krathwohl, & Bloom, 2001). The model consists of six major categories: knowledge, comprehension, application, analysis, synthesis, and evaluation. A deficit identified by clinical preceptors associated with the USM NAP, also known as adjunct faculty, is a weakness in the knowledge base of SRNAs in advanced pharmacology and their ability to recall and apply pharmacological principles in the clinical environment (M. J. Collins, personal communication, September 10, 2018). Thus, one can sensibly predict that though SRNAs have the knowledge and comprehension skills to score well on written tests, they may not be advanced enough in their educational progression to be able to successfully apply, analyze, synthesize, and evaluate necessary pharmacological concepts to put their newly acquired knowledge into practice. The SRNA must enter their clinical training with adequate knowledge of advanced pharmacology so that they can appropriately care for the patients they plan to anesthetize (M. J. Collins, personal communication, September 10, 2018). Consequently, the USM NAP must strive to utilize best practice teaching modalities for pharmacology in anesthesia as to prepare SRNAs so they are equipped to apply, analyze, synthesize, and evaluate drug information and how the content relates to the patient.

To graduate nurse anesthesia school, SRNAs are expected to transition from novices in the field to proficient providers of anesthesia upon graduation. SRNAs are

adult learners who return to school after years of working in the field. Regarding pedagogy or the art of teaching, there is an importance for the adult learner to have the emotional intelligence to determine their best learning style so that they can digest a large amount of information necessary (Teaching Tolerance, 2019). In didactic coursework, class attendance to a lecture with tests to evaluate knowledge is the traditional teaching method. Applying didactic knowledge to answer questions may not get the SRNA to the level they should be at to successfully care for a patient when they enter the hospital because the SRNA may lack contextualization, or the ability to apply new knowledge to a scenario (Dreyfus, 2004). Clinical preparedness can be improved by pushing the student's learning beyond lecture and test-taking. The flipped classroom implements interactive forms of teaching and has been shown to improve the retention of educational material and aid in skills needed for the clinical setting. Even though the flipped classroom teaching method involves the traditional face to face lecture meetings, the flipped classroom utilizes more forms of teaching such as online lectures and simulation and in some instances has yielded higher test results than the traditional classroom setting.

The flipped classroom involves reversing the conventional role of students and faculty members (Berrett, Mangan, Neshyba, Talbert, & Young, 2015). Washington State University's School of Pharmacy and Pharmaceutical Science's guide to the flipped classroom explains what occurs when the flipped classroom is incorporated into a graduate-level curriculum perfectly.

> Instead of passively receiving course content during class, students digest the information outside of class on their own time. They might read written

> materials, watch previously recorded lectures, or listen to a podcast. Once they are in class with their instructors, students spend time answering questions, discussing material, or working in groups. The method has attracted attention in recent years in science, technology, engineering, and mathematics courses. (Berrett et al., 2015)

The idea of the "flipped classroom" was created by two secondary chemistry teachers, Jonathan Bergmann, and Aaron Sams to incorporate interactive activities in the classroom. This teaching method factors in less class time for the traditional lecture during class, contrary to traditional teaching methods, and implements longer blocks of time for discussion and activities. In the flipped classroom, learners do book work (i.e., reading, outlining, and note-taking) at home, before class, and during face-to-face class, the focus of the allotted time is geared towards active learning to achieve academic success. The goal of the new teaching ideas was to improve student satisfaction and retention of new knowledge (Hawks, 2014).

Shifting education in a different direction, the flipped classroom emphasizes active student learning. A shift from traditional, instructional teaching methods, the flipped classroom challenges students by providing different strategies for teaching/learning. Analysts have described the flipped classroom as a backward teaching style because assignments are expected to be completed upon entry into the face-to-face class. From these pre-assignments, students build on concepts in class and contribute to interactive learning activities. Knowledge can be acquired from problem-based learning and case-based learning skills (Persky & McLaughlin, 2017).

In the traditional classroom, class time is spent listening to lecture, answering questions, discussing topics, and reviewing case scenarios (Best & Naber, 2016). Alternatively, Naber and Best describe the in-class strategy for the flipped classroom: "The primary goals of this educational model are to enhance the relevance and retention of knowledge through rich interactive exercises and to facilitate in-depth learning fueled by individual students' aptitude and passion" (Best & Naber, 2016, p. 26).

The role of the course instructor in the traditional setting consists of the dissemination of course content through class attendance and lecture. Historically, instructors utilize textbooks, outlines, study guides, PowerPoint presentations, chalkboards or dry erase boards, projector screens, graphs or images, and discussion to guide their lectures (Berrett, 2015). To summarize the role of the instructor in the flipped classroom, the professor is responsible for unpacking course content, rather than lecturing on the material (Berrett, 2015). For this method to be effective, course instructors must verify that students understand new material (Berrett, 2015). This challenge can be more difficult when students are completing independent learning outside of the classroom. Dan Berrett (2015), explains that "As pressure mounts to graduate more students, and as cognitive psychology produces new insights into how students learn, these observers say professors can no longer simply pump out information and take it on faith that students understand it" (p. 3). For engaged learning to be successful, instructors must be good at answering students' questions on the spot (Berrett, 2015).

In the traditional classroom, students attend scheduled classes on campus and listen to a lecture from a professor (Berrett, 2015). The learner must decide how they will optimize their learning during lecture whether the learner follows the instructor through

the textbook, outline, or PowerPoint presentation; simply listen to the lecturer and read or study outside of class; record the lecture and listen to it again outside of class; or write or type lecture notes. A key point in terms of the lecture environment is the learner to instructor ratio:

> Strained budgets provide difficulty for colleges to decrease class sizes and create more seminars in which low student-to-professor ratios allow a high degree of personal attention. Even advocates for new approaches to teaching concede that the lecture is not going away. The lecture model—putting dozens, hundreds, or even thousands of students in a room with a professor—endures because the model makes economic sense. (Berrett, 2015, p. 3)

The flipped classroom challenges the student to be at the heart of a course, rather than the course instructor (Berrett et al., 2015). Dan Berrett's article, "How 'Flipping' the Classroom Can Improve the Traditional Lecture" explains that by breaking up students into small groups to discuss a principle, students teach each other (2012). By breaking into small groups to discuss anesthesia pharmacology, SRNAs are not only learning anesthesia concepts, but they are practicing interprofessional collaboration. According to the DNP Essentials Task Force (2006), "DNP graduates have preparation in methods of effective team leadership and are prepared to play a central role in establishing interprofessional teams, participating in the work of the team, and assuming leadership of the team when appropriate" (p. 14). By collaborating with their classmates, SRNAs refine their leadership role as a member of an interprofessional team, a function of DNP Essential VI, Interprofessional Collaboration for Improving Patient and Population Health Outcomes (DNP Essentials Task Force, 2006). While promoters suggest this

design is a more effectual method than a traditional lecture, many learners are opposed to this new age format of coursework (Berrett et al., 2015).

A key issue in the graduate curriculum is allotted time for both students and instructors. The allocation of coursework in terms of the amount of available time through the course of a graduate program can be challenging because of the limited amount of time both students and instructors have both inside and outside of class. Time must be rationed for each learning benchmark throughout a NAP curriculum. The traditional learning requires a smaller time investment for the student. Arguably, the learner could potentially be presented with all of the material they need for testing and clinical purposes during class. The success of recall and application of coursework is variable depending on the students' learning styles and how much studying is required for success outside of the classroom.

Alternatively, courses that utilize the flipped classroom add a significant additional amount of time to the SRNAs workload. Students are expected to read multiple chapters prior to class attendance, in addition to other pre-class assignments such as videos, discussion boards, and quizzes. By adding the expectation of additional work before class, students often become overwhelmed and frustrated (Best & Naber, 2016). The flipped classroom is labor-intensive for both the student and the teacher. A larger time commitment is involved in this model for both the learner and the instructor. Instructors should read questions that are submitted by students before class. Replying to learner inquiries about learning objectives is extremely important to both student satisfaction and for successful learning (Best & Naber, 2016).

Rationale

The SRNA's ability to recall and apply pharmacological information in a high-pressure environment, such as the clinical setting, is crucial for patient safety and the student's success. The student's inability to perform under stress in a critical situation could ultimately lead to patient harm or even death. Other negative consequences of the inability for the student to recall and apply pharmacological information could ultimately be dismissal from the nurse anesthesia program (Dhawan et al, 2017). With the goal of all students admitted into nurse anesthesia programs to be successful in the classroom and in the clinical setting, a best practice recommendation for the most effective teaching methods for nurse anesthesia pharmacology was developed based on an extensive literature review and the data collected from the surveys.

Specific Aims

The purpose of this DNP project was to assess the most effective way to teach nurse anesthesia pharmacology and propose a best practice recommendation for the best teaching methods for nurse anesthesia pharmacology. Based on the evidence-based review and student's perception obtained through the surveys, the proposed best practice recommendation has the potential to improve student's ability to recall and apply pharmacological information learned through lecture, videos, and simulation in high-pressure environments associated with clinical and in stressful situations.

Summary

The SRNA's ability to recall and apply pharmacological principles in the clinical setting requires a firm pharmacological background and the ability to perform in high-pressure and stressful settings. Important pharmacological concepts the SRNA must

understand as they enter the clinical setting include dosages, pharmacodynamics, and pharmacokinetics (Nagelhout, 2014a). SRNAs must apply these concepts in high-pressure real-world settings. Studies have shown the students' desire for success and academic excellence contributes to the high-pressure environment created in the clinical setting (Crouzevialle et al, 2015). Situations in clinical along with external factors can lead to increased stress in SRNA. Stress in the setting of learning is fundamental to the progressive motivation of students. However, stress that extends beyond a moderate level can lead to negative consequences (Mckay et al, 2010).

The NAP curriculum for nurse anesthesia pharmacology can play an important role in the success of the SRNA. Bloom's Taxonomy, a model for categorizing educational progression, consists of six major categories: knowledge, comprehension, application, analysis, synthesis, and evaluation (Anderson et al, 2001). A deficit identified by clinical preceptors associated with the USM NAP, also known as adjunct faculty, is a weakness in the knowledge base of SRNAs in advanced pharmacology and their ability to recall and apply pharmacological principles in the clinical environment (M. J. Collins, personal communication, September 10, 2018). Teaching modalities should support the enhancement of pharmacological curriculum to prepare the SRNA to apply, analyze, synthesize, and evaluate drug information and how the material relates to the patient.

The traditional didactic coursework aids the SRNA in answering questions on a test but may not help the SRNA achieve the level of understanding needed to apply the information once in clinical (Dreyfus, 2004). The flipped classroom implements interactive forms of teaching and has been shown to improve the retention of educational

material and aid in skills needed for the clinical setting. The flipped classroom involves traditional face to face lecture and utilizes other forms of teaching such as online lectures and simulation (Berrett et al, 2015).

CHAPTER II - METHODS

Context

The systematic review performed through this DNP project consisted of both a review of literature and collection of data by way of the dissemination of surveys among two cohorts of USM SRNAs that were taught anesthesia pharmacology using two different teaching platforms. Both cohorts were taught pharmacology over the course of two semesters during their first year of the NAP. The first cohort surveyed, the NAP class of 2018, was taught advanced pharmacology over the first and second semesters of the NAP. These students were polled prior to the formulation of this project using a survey created by the committee chair of this project, Dr. Mary Jane Collins. The second cohort surveyed, NAP class of 2020, were taught advanced pharmacology over the course of the second and third semesters of the NAP because of a change in curriculum so that students would complete their didactic pharmacology coursework closer to the timeframe when they would enter the clinical setting for the first time. The first surveyed cohort of nineteen USM NAP students watched anesthesia pharmacology lecture videos on their own time and on their own personal computers before attending class on campus. During class time, the course instructor reviewed the topics discussed in the video lecture and asked questions and facilitated class discussions. The second cohort of SRNAs to complete a survey currently has twenty students. These students also watched pre-recorded advanced pharmacology video lectures from a widely published nurse anesthesia professor. During class time, these SRNAs accompanied the course professor to the high-fidelity simulation lab in the USM nursing building to practice mock anesthetic scenarios and determine which actions to take using medications. The

difference between the two surveyed populations is the teaching platforms in which they learned advanced pharmacology during scheduled class time. The USM NAP currently has advanced pharmacology for anesthesia divided into two, consecutive semesters. NUR 832, Advanced Pharmacology for Anesthesia I, is being taught over the second semester of the anesthesia program at present. The second advanced pharmacology NAP course, NUR 833, is taught over the third semester (Policies and Procedures Manual, 2019). The currently available knowledge regarding effective teaching platforms to teach advanced pharmacology to anesthesia students is limited. However, the surveys that were disseminated to SRNAs were created with effective pedagogy in mind.

Interventions, Study of Interventions, and Measures

In the first five years of the program, pharmacology courses at the USM NAP utilized video-only teaching methods with no lecture or simulation components. Due to concerns voiced by preceptors about SRNA's pharmacology knowledge base and ability to recall and apply pharmacological principles and student feedback regarding teaching methods used for courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II , a new teaching method of combining pharmacology videos to be watched outside of the classroom along with assigned reading, in-class discussion of the videos and difficult concepts, and simulation lab where information from the videos and reading could be applied was introduced (M. J. Collins, personal communication, September 10, 2018). To determine whether the new teaching methods are effective, a thorough literature review was conducted to uncover the available knowledge associated with the best practices for teaching methods for pharmacology students to prepare them for the clinical setting. The terminology used for

searching in databases and the internet included but were not limited to, pharmacology, pharmacokinetics, pharmacodynamics, flipped-classrooms, pedagogy, NAP requirements, pharmacology simulation, pharmacology class, high-pressure performance, stress in clinical environments, and Bloom's Taxonomy. Databases utilized for this literature review were CINAHL, PubMed, Google Scholar, and Medline. Along with these databases, sources of information were also found using the Council of Accreditation website, the USM website, and DNP Essentials. Using Boolean Operators, results from the databases and sources yielded 5,350 articles. The inclusion criteria for narrowing the results included (a) publication during or following the year 2004, (b) comparisons between traditional classrooms and flipped classrooms, (c) graduate programs including other specialties such as pharmacy programs, (d) high-pressure performance and stress in the clinical setting, and (e) requirements for NAP. The exclusion criteria consisted of any information that would negate the inclusion criteria such as undergraduate learning.

Commonalties found during the literature review included the high-pressure stress students feel when entering the clinical environment unprepared. The most common theme associated with these findings was the teaching methods utilized. Among the teaching methods reviewed, the flipped classroom yielded the highest response in test scores and the preparedness of students. Not only were examination scores higher, but there was a higher student approval rating for the flipped classroom teaching including prerecorded lectures and other active learning techniques (Wong, Ip, Lopes, & Rajagopalan, 2014, p. 1).

With the information gained from the literature review, a survey was created about the courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II. The survey was created based on the survey developed to determine student perception of nurse anesthesia pharmacology courses disseminated by USM to the Cohort of nineteen USM SRNAs who graduated in December 2018. The 2018 Cohort Survey is shown in Appendix A. The format of this survey was based on pharmacology taught through a video-only format. An intervention was made by creating a new survey and disseminating the survey to the 2020 Cohort of twenty SRNAs at USM who were taught courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II using videos, supplemental discussion, and simulation. The key differences between the 2018 Cohort Survey and the 2020 Cohort Survey were the teaching methods. The 2020 Cohort Survey found in Appendix B was distributed to the USM NAP 2020 Cohort via email shown in Appendix C, and students were able to use Qualtrics to complete the surveys anonymously. Participation was not required, and no identifiers were placed on the surveys so that each student may remain anonymous. Three domains of questions were asked surrounding two domains linked to the teaching format of video instruction combined with simulation. Learning and understanding pharmacological principles are important and relevant to the project because SRNAs must be able to recall and apply these principles in the clinical environment to be successful and provide a safe anesthetic to patients. Recollection and application of pharmacological principles are important and relevant to the project because SRNAs must be able to perform these principles under

stress in high-pressure environments. The 2020 Cohort Survey created is shown in Appendix B.

The composition of the panel of experts consisted of five people: a faculty representative, a pharmacology education representative, a health policy expert, a clinical preceptor from a hospital who sees students from different programs and last a clinical coordinator who sees students from different years of the program. The faculty representative is an important member because educational models were evaluated throughout the project. Because the project discusses teaching methods of pharmacology, a pharmacology education representative served as an important stakeholder in the pharmacological concepts of the project. The health policy expert was influential in guiding the creating a best practice recommendation for the most effective teaching methods for pharmacology. The clinical preceptor who see students from different programs and the clinical coordinator who has evaluated both cohorts are beneficial for the project by providing a comparison between programs and the two different cohorts being surveyed.

Steps

1. The project was proposed to the DNP project committee.
2. Once approval was gained through the project team; the International Review Board (IRB) application was submitted for approval through USM. The IRB approval letter is shown in Appendix D.
3. A best practice review was performed regarding the most effective methods for teaching nurse anesthesia pharmacology.

4. The survey was administered to the current second-year cohort according to described inclusion and exclusion criteria.
5. Survey results were compared to survey results of cohort 2018. Common themes were noted.
6. Utilizing best practice review and survey comments, a best practice recommendation for most effective teaching method for nurse anesthesia pharmacology was developed.
7. A panel of experts were compiled according to described criteria.
8. The best practice recommendation is shown in Appendix E along with references, survey results, and review of findings were presented to the panel of experts via email.
9. The panel of experts evaluated the best practice recommendation and the level of doctoral work anonymously using Qualtrics.
10. The best practice recommendation was altered to reflect evaluation comments and results, if necessary.
11. Edited best practice recommendation was presented to the DNP Committee for approval.
12. Executive Summary, Review of Findings, and Best Practice Recommendation were presented to USM NAP faculty and administration.
13. Dissemination of the project was presented.

Summary

In the first five years of the program, pharmacology courses at the USM NAP utilized video-only teaching methods with no lecture or simulation components. Due to

concerns voiced by preceptors about SRNA's pharmacology knowledge base and ability to recall and apply pharmacological principles and student feedback regarding teaching methods used for courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II , a new teaching method of combining pharmacology videos to be watched outside of the classroom along with assigned reading, in-class discussion of the videos and difficult concepts, and simulation lab where information from the videos and reading could be applied was introduced (M. J. Collins, personal communication, September 10, 2018).

The comparative analysis performed through this DNP project consisted of both a review of literature and collection of data by way of the dissemination of surveys among two cohorts of USM SRNAs that were taught anesthesia pharmacology using two different teaching platforms. Commonalties found during the literature review included the high-pressure stress students feel when entering the clinical environment unprepared. The most common theme associated with these findings was the teaching methods utilized. Among the teaching methods reviewed, the flipped classroom yielded the highest response in test scores and the preparedness of students. Not only were examination scores higher, but there was a higher student approval rating for the flipped classroom teaching including prerecorded lectures and other active learning techniques (Wong, Ip, Lopes, & Rajagopalan, 2014, p. 1).

The data for this comparative analysis was collected through surveys completed by USM SRNAs from the 2018 and 2020 cohorts. Both cohorts were taught pharmacology over the course of two semesters during their first year of the NAP. The first cohort surveyed, the NAP class of 2018, were polled prior to the formulation of this

project using a survey created by the committee chair of this project, Dr. Mary Jane Collins. The first surveyed cohort of nineteen USM NAP students watched anesthesia pharmacology lecture videos on their own time and on their own personal computers before attending class on campus. During class time, the course instructor reviewed the topics discussed in the video lecture and asked questions and facilitated class discussions. The second cohort of SRNAs to complete surveys currently has twenty students. These students also watched pre-recorded advanced pharmacology video lectures from a widely published nurse anesthesia professor. During class time, this group of SRNAs accompanied the course professor to the high-fidelity simulation lab in the USM nursing building to practice mock anesthetic scenarios and determine which actions to take using medications.

CHAPTER III - RESULTS

A best practice policy recommendation (Appendix E) regarding the most effective teaching methods for teaching nurse anesthesia pharmacology was presented to a panel of experts. The recommendation was presented utilizing a report of findings (Appendix F) which was formulated based on available knowledge, with references provided, which was gathered through an extensive literature review involving the most effective methods for teaching nurse anesthesia pharmacology. Data was gathered by disseminating the Cohort Survey, formulated for the 2020 USM NAP cohort (Appendix B), which focuses on advanced anesthesia pharmacology taught using video instruction with supplemental discussion and simulation as the delivery format. A comparison was made utilizing the results from the 2020 Cohort Survey and the 2018 Cohort Survey of thirteen completed surveys (Appendix A). The results from the 2018 Cohort Surveys are shown in Table 2, and the results from the 2020 Cohort Surveys are shown in Table 3. The panel of experts' input was assessed by an evaluation tool (Appendix G) regarding the information found in the report of findings assessing if the information was valuable, of high quality, would be effective for teaching nurse anesthesia pharmacology, and whether the policy should be adopted. The panel of experts were given the chance to state their opinions face-to-face or using the evaluation tool on the best practice recommendation for nurse anesthesia pharmacology.

The expert panel members were composed of a faculty representative, a pharmacology education representative, a health policy expert, a clinical preceptor, and a clinical coordinator. A review of findings and best practice recommendation were sent to the selected panel members. Four out of the five chosen members completed the

anonymous online surveys. Two reminders were sent to the panel reminding them about the survey; however, only four surveys were completed. The four panels members agreed the proposed best practice recommendation would be effective in teaching advanced nurse anesthesia pharmacology, would aid SRNAs in their preparedness for clinical, and would benefit the USM NAP. The results of the evaluation tool are found in Table 1.

Table 1

Panel of Experts' Beliefs on the Proposed Best Practice Recommendation

Evaluation Tool Questions and Prompts	Panelist #1	Panelist #2	Panelist #3	Panelist #4
The suggestions provided should be effective in teaching advanced pharmacology to SRNAs.	Strongly Agree	Agree	Strongly Agree	Agree
The suggestions provided should aid SRNAs in their preparedness for the clinical setting.	Strongly Agree	Agree	Strongly Agree	Strongly Agree
The best practice recommendation seems realistic for the USM NAP to	Strongly Agree	Agree	Strongly Agree	Agree

Table 1
Continued

adopt into the curriculum.				
The information provided was of high quality.	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Strongly Agree
Do you believe the proposed best practice recommendation will be of benefit to the USM NAP?	Yes	Yes	Yes	Yes
Other Feedback		"Although I agree with the recommendations to an extent, I think the individuals surveyed was a small sample size. I would also encourage students to find the best way for them to learn and get it done."		

Out of the 13 students who completed the 2018 Cohort Survey, 9 students listed recommendations for future nurse anesthesia pharmacology classes. One of the recommendations by a student stated, "I think face to face learning along with some

visual and auditory interaction would be better" while another student stated, "In class lecture after student reading assignment plus lecture to test application and dose/onset/duration of action, etc. Laboratory simulation to learn what to expect with dose and vials." Other concerns of students were that medication dosages were not being taught using the video-only format. One student stating, "Did not have to learn dosages." Another concern verbalized by students was that they were not able to ask questions regarding information learned from the videos watched due to the absence of the traditional classroom setting. Pros listed for the video only format were associated with the time efficiency of the videos. The greatest concern listed in the survey comments appeared to be the deficiency of teaching medication dosages with the video only format.

Table 2

Results of Cohort 2018-Survey

Evaluation Tool and Questions	Yes	No	Comments
1. Did the Video Only delivery format enable you to learn and understand the pharmacological principles (such as pharmacodynamics, pharmacokinetics, mechanisms of action, and routes	7	6	*"It would have helped to be in person so we could ask questions when we were confused."; "Would have liked more in-depth"; "Video lecture was only beneficial if the chapter was already read."*

Table 2 Continued

	of elimination) for the presented drugs?			
2.	Did the Video Only delivery format enable you to learn and understand the recommended dosages for the presented drugs?	6	7	*"Didn't have to learn dosages."; "He didn't require us to learn doses"; "We didn't have to learn doses"; "too many conflicting sources"; "The chapter needed to be read."*
3.	Did the Video Only delivery format enable you to learn and understand the onset of times, duration of action, and half-lives for the presented drugs?	8	5	*"Not required"; "Was not required"; "No this was only beneficial to the book"*
4.	Did the Video Only delivery format enable you to recall and apply pharmacological principles	4	9	*"Learning it over and over helped."; "Consider adding pharm questions to lectures/anesthesia principle courses"*

Table 2 Continued

	(pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) effectively upon entering clinical education and in high-stress clinical situations?			
5.	Did the Video Only delivery format enable you to recall and apply dosage, onset times, duration of action, and half-lives effectively upon entering clinical education and in high-stress clinical situations**?**	3	10	*"Esp. NOT dosages"; "because it was taught almost a year before we start clinical"; "Consider adding pharm questions/lectures to anesthesia principle courses"*
6.	Would a different course format	11	2	*"Blend of the delivery formats"; "Face to face lecture plus video*

Table 2 Continued				
	enable you to learn and understand pharmacological principles, including dosage information, more effectively? Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of the delivery formats.			*and reading chapter may be helpful"*
7.	Would a different course format enable you to apply pharmacological principles, including dose information, more effectively upon entering clinical and	10	3	*"Combination of video and traditional lecture (1 x month)"; "Videos are ok if there's time dedicated to answering questions"*

Table 2 Continued

	in high-stress clinical situations? Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of delivery formats.			
8.	Do you have any recommendations for improvement in the delivery format of the pharmacology classes listed?	10	*3*	*"Anything I would add would be a traditional lecture (1 x month) to review lectures covered from previous 3 weeks. I really liked the video format and believed it was helpful and time-efficient."; "In class use of Nagelhout, Valley, and Apex. Keep Nagelhout of course."; "The video's do not provide all the information needed and we didn't have to learn any drug dosages."; "I think a face to face*

Table 2 Continued	*learning along with some visual and auditory interaction would be better"; "In class is better"; "Pharm is the core of our profession. Face to face is better I think"; "If video classes are kept, they should be supplemented with in-person lectures also."; "In class lecture after student reading assignment plus lecture to test application and dose/onset/DOA etc. Lab sim to learn what to expect with dose and vials concentration"; "Blend video and face-to-face lectures"*

The results from the 2020 Cohort Survey are shown in Table 3. At the time of the survey administration, the students had been in clinical for approximately seven months. Out of 20 students, 8 students responded to the survey and submitted feedback regarding the video instruction with supplemental discussion and simulation format. Regarding the video lectures, one student believed the video lecture was vague on dosage recommendations while another student believed the video professor did a good job in the area of drug onset times, duration of action, and half-lives for drugs. Students found the additional material utilized in class to be helpful and one student stated, "I still use my composition draw in book from time to time" and another student stated, "Utilizing

my note cards, hanging poster displays of drug information helped tremendously." Students found the supplemental in-class activities and the videos sufficient but requested the traditional classroom portion have interacted via telecommunication versus in-class discussion. Another SRNA noted, "The in-class activities helped to enhance the video learning and it allowed for a hands-on approach." The negative comments received from the surveys were associated with the video lectures. Students made comments stating the videos were vague and at times were even contradictory between the video lecture, workbook, and textbook. When asked if a different course format would enable a better understanding of pharmacology, seven out of eight students answered yes, stating, "Blended. As much as I hate coming to class, I'll pay attention more than just video. Doing simulation helps you remember that situation so you can apply it later."

Table 3

Results of Cohort 2020-Survey

Evaluation Tool and Questions	Yes	No	Comments
1. Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to learn and understand the pharmacological	8	0	"I found it to be sufficient in this area. I do think that it would have been better if we could have interacted via telecommunication with the instructor."; "Nagelhout? He read word for word from his PPTs. I like that better than in class, but the videos took a long time."; "Yes, the in-class activities

Table 3 Continued				
	principles (such as pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) for the presented drugs?			helped to enhance the video learning. It allowed for a hands-on approach."
2.	Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to learn and understand the recommended dosages for the presented drugs?	4	4	"It was sufficient"; "Yes, utilizing note cards, hanging poster displays of drug information helped tremendously"; "Not necessarily. I'm always going back even now to look them up."; "The video lecture was very vague and contradictory on dosage recommendations."
3.	Did the Video Instruction with Supplemental Discussion and Simulation	4	4	"I think Nagelhout did a good job in this area."; "I don't remember Nagelhout going over that. I found it online somewhere else.":" The video lecture was very

Table 3 Continued				
	delivery format enable you to learn and understand the onset of times, duration of action, and half-lives for the presented drugs?			vague and contradictory regarding this subject."
4.	Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to recall and apply pharmacological principles (pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) effectively upon entering clinical	7	1	"I think that the video supplies enough info but students themselves had to learn how to recall and apply to clinical."; "I still use my composition draw in book from time to time."

Table 3 Continued

	education and in high-stress clinical situations?			
5.	Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to recall and apply dosage, onset times, duration of action, and half-lives effectively upon entering clinical education and in high-stress clinical situations?	5	3	That was when I realized I didn't take as much from that class as I thought I did.
6.	Would a different course format enable you to learn and understand pharmacological principles,	7	1	"Maybe a more interactive course with the instructor."; "Blended. As much as I hate coming to class, I'll pay attention more than just videos. Doing simulation helps

Table 3 Continued				
	including dosage information, more effectively? Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of the delivery formats.			you remember that situation so you can apply it later."; "I believe that the video instruction was adequate for the basic pharmacological principles of the various drugs, but the instruction lacked adequate information on dosing and real-world application. I believe that face-to-face traditional lecture with ability to ask questions in real-time would dramatically improve this course."; "A blend of the methods would enhance learning."
7.	Would a different course format enable you to apply pharmacological principles, including dose information, more effectively upon entering clinical and in high-stress	6	2	"Face-to-face lecture with the ability to ask questions in real-time and the inclusion of real-world dosing vs. "book" dosing would be helpful. I also believe that clinical scenarios would help."; "I think clinicals are just stressful due to the "bullying" that nurses are known for."

Table 3 Continued

	clinical situations? Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of delivery formats.			
8.	Do you have any recommendations for improvement in the delivery format of the pharmacology classes listed?	4	4	"The video format was good, but vasopressor drugs need to be looked at more. Please provide updated tables with drugs, safe dose range, etc. with references."; "I think it should be taught the entire first year. Not crammed into summer/fall. If you build on the material, it might make clinical transition smoother."; "More time needs to be spent with actual face-to-face instruction with the ability for the student to ask questions in real-

Table 3 Continued	time. There also needs to be more real-world dosing considerations vs. "book" dosing."; "Yes. The videos and supplemental reading were great. However, importance wasn't placed on dosage onset of action and elimination."

Summary

Based on the comparative analysis, created through a compilation of the current published research regarding pharmacology in anesthesia and student feedback through survey results, this doctoral project suggests the flipped classroom teaching modality as the recommended teaching format for nurse anesthesia advanced pharmacology courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II. Through feedback from USM SRNAs and a literary review of pedagogy, this project reveals that the flipped classroom allows student to learn independently from home, have face-to-face time in the classroom to discuss difficult topics and complete adjunctive methodologies, and time for simulation to apply pharmacological principles.

Students from both surveyed Cohorts agreed that though pharmacology videos were helpful in their learning, additional teaching modalities should be utilized to teach anesthesia pharmacology. Both cohorts recommended face-to-face time with the course

instructor as well as time to run through case scenarios in the simulation lab. Several surveyed SRNAs found the in-class discussions helpful. The majority of surveyed students agreed that a blend of teaching modalities for pharmacology in anesthesia was the ideal scenario in term. A review of findings and best practice recommendation was sent to a panel of experts which consisted of faculty representative, a pharmacology education representative, a health policy expert, a clinical preceptor, and a clinical coordinator. Four of the five panelists submitted feedback to the best practice recommendation. The panelists were in agreeance on the proposed best practice recommendation for the USM NAP, utilizing the flipped classroom method for advanced pharmacology. They agreed the proposed recommendation would be effective in teaching advanced nurse anesthesia pharmacology to SRNAs, would aid SRNAs in their preparedness for clinical, and would benefit the USM NAP.

CHAPTER IV – DISCUSSION

Summary

An emerging healthcare culture centered around patient safety is shifting how healthcare personnel are being educated (Wunder, Glymph, Newman, Gonzalez, & Groom, 2014). The training of SRNAs to be safe and competent providers of anesthesia for the public, have a firm understanding of advanced pharmacology and how medications may affect patients is vital to the success of the SRNA. SRNAs must be able to learn, understand, and apply the advanced pharmacology that they are taught over two semesters as they begin their second year of anesthesia school and enter the clinical setting where they perform anesthetics on real patients. Prior to entering the clinical environment, SRNAs at USM have the opportunity to utilize the state-of-the-art simulation lab to run through case scenarios as they could occur in real-life. The use of simulation to imitate real-life scenarios is showing great promise in effectively assessing the clinical competence of students in their healthcare education before they enter the clinical setting (Wunder et al., 2014). This doctoral project seeks to shed light on what teaching modalities are effective in adequately teaching SRNAs advanced pharmacological concepts so that they are able to learn, recall, and apply this essential knowledge in the clinical arena.

Interpretation

To gauge what literature currently reports in relation to sufficient teaching methods in nurse anesthesia pharmacology, a synthesis of available knowledge was compiled. This compilation of literature sought to outline pharmacological concepts important to the delivery of anesthesia, SRNAs performing in high-pressure

circumstances, stress that accompanies the role as an SRNA, and pedagogy. Additionally, a survey was created to collect data from USM NAP cohorts 2018 and 2020 (Appendix D), who were taught both semesters of advanced pharmacology utilizing slightly different teaching modalities, to determine what their takeaways were regarding their learning and understanding of advanced pharmacology and their ability to apply newly acquired concepts in the clinical setting. Using the synthesis of available knowledge and the results of both surveys, a report of findings (Appendix F) was compiled as well as a best practice recommendation (Appendix H). The report of findings and best policy recommendation was presented to a panel of experts along with an evaluation tool for each panelist to offer their own feedback (Appendix G). After the evaluation tool with comments from the panel of experts was assessed, a final best practice recommendation was presented to the USM NAP faculty.

Limitations

A limitation to the current analysis is that presently, no literature exists that explicitly recommends a specific teaching modality for nurse anesthesia pharmacology. With that said, this project inspected what literature says about pharmacological concepts, performance under pressure, stress, and pedagogy and combine the findings from each of these areas to form a realistic inference in reference to the most sufficient methods to teach nurse anesthesia pharmacology. Another limitation to the study was that the data gathered from the surveys disseminated to USM SRNAs came from small sample size and from a single program.

Conclusion

Recall and application of pharmacological concepts is difficult in high-pressure, real-world settings for nurse anesthesia students new to clinical practice (Crouzevialle et al, 2015). The SRNA's inability to recall and apply pharmacological information in the clinical setting has the potential to negatively impact patient safety and student performance. Incorrect actions made by the SRNA toward patients undergoing surgical procedures can result in harm to patients in the preoperative, intraoperative, and postoperative periods, as well as after patients return either to a hospital room or to their own homes (Dhawan et al., 2017). The cause of patient safety violation could be the result of medication errors, adverse drug events, or from failure to treat which is all attributed to human error (Dhawan et al., 2017). Additionally, the result could be dismissal from the clinical day with the possibility of probation if the student is unable to intervene when indicated and, thus, perform the appropriate action in a given clinical scenario. The cause of negatively impacting student performance could be linked to extreme stress in the clinical environment (McKay et al., 2010). A review of best practices was performed to ascertain the most effective teaching platforms for nurse anesthesia pharmacology. Based on literary evidence and results from student surveys within the USM NAP, a best practice recommendation was developed, presented to a panel of experts for feedback, and finally proposed to the USM NAP faculty for consideration.

The best practice policy recommendation, resulting from this doctoral project, suggesting a flipped classroom method for advanced pharmacology within the USM NAP has the potential to prevent the negative consequences mentioned above. Out of the 13

students who completed the 2018 Cohort Survey, 9 students listed recommendations for future nurse anesthesia pharmacology classes. One of the recommendations by a student stated, “I think face to face learning along with some visual and auditory interaction would be better” while another student stated, “In class lecture after student reading assignment plus lecture to test application and dose/onset/duration of action, etc. Lab simulation to learn what to expect with dose and vials”. Other concerns of students were that medication dosages were not being taught using the video-only format. One student stating, “Didn’t have to learn dosages”. Another concern verbalized by students was that they were not able to ask questions regarding information learned from the videos watched due to the absence of the traditional classroom setting. Pros listed for the video only format were associated with the time efficiency of the videos. The greatest concern listed in the survey comments appeared to be the deficiency of teaching medication dosages with the video only format.

APPENDIX A – 2018 Cohort Survey

Waiver Statement: Participation in this study is voluntary. There will no repercussions for nonparticipation.

Instructions: 1- Please answer the following questions. Do not indicate any identifying information, such as name or other personal information. 2- Return questionnaire to Dr. Everson upon completion. 3- Thank you for your voluntary participation.

In reference to NUR 832: Advanced Pharmacology for Anesthesia I and
NUR 833: Advanced Pharmacology for Anesthesia II:

1. Did the Video Lecture Only delivery format enable you to learn and understand the pharmacological principles (such as pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) for the presented drugs?

Yes No

Comments:

_____

2. Did the Video Lecture Only delivery format enable you to learn and understand the recommended dosages for the presented drugs?

Yes No

Comments:

_____

3. Did the Video Lecture Only delivery format enable you to learn and understand the onset times, duration of action, and half-lives for the presented drugs?

Yes No

Comments:

_____

4. Did the Video Lecture Only delivery format enables you to recall and apply pharmacological principles (pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) effectively upon entering clinical education and in high-stress clinical situations?

Yes No

Comments:

_____

5. Did the Video Lecture Only delivery format enable you to recall and apply dosages, onset times, duration of action, and half-lives effectively upon entering clinical education and in high-stress clinical situations?

Yes No

Comments:

_____

6. Would a different course format enable you to learn and understand pharmacological principles, including dosage information, more effectively? *Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of the delivery formats.*

Yes No

Comments:

_____

7. Would a different course format enable you to apply pharmacological principles, including dosage information, more effectively upon entering clinical and in high-stress clinical situations? *Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of the delivery formats.*

Yes No

Comment:

_____

8. Do you have any recommendations for improvement in the delivery format of the pharmacology classes listed?

Yes No

Comments:

_____

APPENDIX B – 2020 Cohort Survey

Waiver Statement: Participation in this study is voluntary. There will no repercussions for nonparticipation. By completing this questionnaire, you are agreeing to participate in the study.

Instructions: 1- Please answer the following questions. Do not indicate any identifying information, such as name or other personal information. 2- Complete the survey anonymously via Qualtrics. 3- Thank you for your voluntary participation.

In reference to NUR 832: Advanced Pharmacology for Anesthesia I and
NUR 833: Advanced Pharmacology for Anesthesia II:

1. Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to learn and understand the pharmacological principles (such as pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) for the presented drugs?

   Yes No

   Comments:

   _____

2. Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to learn and understand the recommended dosages for the presented drugs?

Yes No

Comments:

_____

3. Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to learn and understand the onset times, duration of action, and half-lives for the presented drugs?

Yes No

Comments:

_____

4. Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to recall and apply pharmacological principles (pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) effectively upon entering clinical education and in high-stress clinical situations?

Yes No

Comments:

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5. Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to recall and apply dosages, onset times, duration of action, and half-lives effectively upon entering clinical education and in high-stress clinical situations?

Yes No

Comments:

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6. Would a different course format enable you to learn and understand pharmacological principles, including dosage information, more effectively? *Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of the delivery formats.*

Yes No

Comments:

_____

7. Would a different course format enable you to apply pharmacological principles, including dosage information, more effectively upon entering clinical and in high-stress clinical situations? *Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of the delivery formats.*

Yes No

Comments:

_____

8. Do you have any recommendations for improvement in the delivery format of the pharmacology classes listed?

Yes No

Comments:

_____

APPENDIX C – Proposed Email Announcement

Dear SRNA,

We are conducting research on ***presentation formats of pharmacology courses in nurse anesthesia education****. We are inviting you to participate because you have completed NUR 832 and NUR 833, Advanced Pharmacology for Nurse Anesthesia I and II. Participation in this research includes answering a questionnaire about your perception of learning, knowledge retention, and application recall of pharmacological principles and drug administration information related to the* ***video Instruction with supplemental discussion and simulation*** *of your courses. If you agree to complete this voluntary anonymous questionnaire, it will take approximately 30 minutes. Participation is voluntary; there will be no repercussions for non-participation.*

If you have any questions, please contact us using the information provided below.

Thanks in advance for your time and cooperation!

Lane Bielstein

Email: Lane.Bielstein@usm.edu

Phone Number: (985) 249-9320

Jordan Eldridge

Email: Jordan.Eldridge@usm.edu

Phone Number: (662) 571-3176

APPENDIX D – IRB Approval Letter

Office *of*
Research Integrity

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

118 COLLEGE DRIVE #5125 • HATTIESBURG, MS | 601.266.6576 | USM.EDU/ORI

NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.

PROTOCOL NUMBER: IRB-19-317
PROJECT TITLE: Effective Teaching Modalities in Nurse Anesthesia Pharmacology
SCHOOL/PROGRAM: School of LANP
RESEARCHER(S): Lane Bielstein, Jordan Eldridge, Mary Jane Collins,
IRB COMMITTEE ACTION: Exempt
CATEGORY: Exempt

Category 1. Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

APPROVED STARTING: July 22, 2019

Donald Sacco Jr.

Donald Sacco, Ph.D.

Institutional Review Board Chairperson

APPENDIX E – Best Practice Recommendation

Practice Area: The University of Southern Mississippi Nurse Anesthesia Program

Subject: Advanced Pharmacology in Nurse Anesthesia

Title of Recommendation: Effective Teaching Modalities for Advanced Pharmacology in Nurse Anesthesia Programs

Based on both the review of literature and the data acquired through feedback from the 2018 and 2020 cohort surveys, a best practice recommendation was created representing the most effective teaching modality for the USM NAP advanced pharmacology courses.

- Platforms researched included traditional lecture, flipped classrooms, and simulation. Flipped classrooms utilizes a variety of teaching formats such as online lectures, simulation, and a traditional classroom setting.
- Students from both 2018 and 2020 Cohorts agreed the pharmacology videos were helpful, but more teaching methods should be utilized in the pharmacology courses. Both cohorts recommended face-to-face time with the instructor and time also being spent in the simulation lab. The 2020 Cohort specifically mentioned adjunctive teaching methodologies such as drug notecards and a poster display of drug information helped with retaining the pharmacological principles.
- Based on the available knowledge and student feedback, the flipped classroom setting is the recommended teaching format for nurse anesthesia advanced pharmacology courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II. The flipped

classroom allows student to learn independently from home, have face-to-face time in the classroom to discuss difficult topics and complete adjunctive methodologies, and time for simulation to apply pharmacological principles.

APPENDIX F – Report of Findings

Introduction

When student registered nurse anesthetists (SRNAs) enter the clinical setting, clinical instructors and preceptors expect students to arrive prepared to recall and apply pharmacological concepts learned through their didactic coursework (Nurse Anesthesia Program, 2019). Through this challenge, a question is raised: What is the most effective way to teach pharmacology to SRNAs so that knowledge can be effectively translated into clinical practice? One challenge of nurse anesthesia education is relaying information so SRNAs are taught how to take their learning beyond test-taking and into implementing their knowledge of pharmacology. This process is necessary so SRNAs can safely anesthetize patients in a timely manner and under tense circumstances.

Problem Description

Recall and application of pharmacological concepts are difficult in high-pressure, real-world settings for nurse anesthesia students new to clinical practice (Crouzevialle, Smeding, & Butera, 2015). The SRNA's inability to recall and apply pharmacological information in the clinical setting has the potential to negatively impact patient safety and student performance. Incorrect actions made by the SRNA toward patients undergoing surgical procedures can result in harm to patients in the preoperative, intraoperative, and postoperative periods, as well as after patients return either to a hospital room or to their own homes (Dhawan, Tewari, Sehgal, & Sinha, 2017). The cause of patient safety violation could be the result of medication errors, adverse drug events, or from failure to treat which is all attributed to human error (Dhawan et al., 2017). Additionally, the result could be dismissal from the clinical day with the possibility of probation if the student is

unable to intervene when indicated and, thus, perform the appropriate action in a given clinical scenario. The cause of negatively impacting student performance could be linked to extreme stress in the clinical environment (McKay, Buen, Bohan, & Maye, 2010). A review of best practices was performed to ascertain the most effective teaching platforms for nurse anesthesia pharmacology. Based on literary evidence and results from student surveys within The University of Southern Mississippi (USM) Nurse Anesthesia Program (NAP), a best practice recommendation was developed, presented to a panel of experts for feedback, and finally proposed to the USM NAP faculty for consideration.

Available Knowledge

According to Dr. Nagelhout in his book, *Nurse Anesthesia*, SRNAs must understand important pharmacological concepts such as medication dosages, pharmacodynamics, and pharmacokinetics (Nagelhout, 2014a). Along with these principles, students must understand the population and genetic profile of each patient and the significant effects these factors can have on the anesthetic delivered. Anesthetists have a duty to recognize the variability inpatient care to prevent adverse outcomes from improper drug dosing (Nagelhout, 2014a, p. 55). SRNAs must also learn new information regarding the administration and monitoring with inhalational anesthetics such as the primary components affecting the delivery of the anesthetic gas which are absorption of the inhalational anesthetic, ventilation, uptake into the blood, cardiac output, the solubility of the anesthetic drug in the blood, and the alveola-to-venous blood partial pressure difference (Nagelhout, 2014b, p. 78). Identification of necessary pharmacological principles is important to this project for the anesthesia provider to be

successful in the clinical setting and to provide a safe anesthetic to patients undergoing surgical procedures.

Often, SRNAs must apply and recall pharmacological principles in high-pressure environments. The "choking under pressure" phenomenon was conceived to help understand these situations and how people are likely to respond. Hypotheses associated with the phenomenon are individuals with higher ability than others are most likely to have a subpar performance under pressure (Wang & Shah, 2013). In some circumstances, the clinical environment may be calm with little performance pressure; however, the SRNA must always be prepared for any situation that may occur. The SRNA must be able to actively recall medications and dosages when needed. Studies have shown the students' desire for success and academic excellence contributes to the high-pressure environment created in the clinical setting (Crouzevialle, Smeding, & Butera, 2015).

In 1956, Benjamin Bloom, along with Max Englehart, Edward Furst, Walter Hill, and David Krathwohl developed and published a model for categorizing educational progression referred to as Bloom's Taxonomy (Anderson, Krathwohl, & Bloom). The model consists of six major categories: knowledge, comprehension, application, analysis, synthesis, and evaluation. A deficit identified by clinical preceptors associated with the USM NAP, also known as adjunct faculty, is a weakness in the knowledge base of SRNAs in advanced pharmacology and their ability to recall and apply pharmacological principles in the clinical environment (M. J. Collins, personal communication, September 10, 2018). Thus, a prediction is made that though SRNAs have the knowledge and comprehension skills to score well on written tests, they may not be advanced enough in their educational progression to be able to successfully apply, analyze, synthesize, and

evaluate necessary pharmacological concepts to put their newly acquired knowledge into practice. Prior to entering clinical training, the SRNA must have adequate knowledge of advanced pharmacology so they can appropriately care for the patients they plan to anesthetize (M. J. Collins, personal communication, September 10, 2018). Consequently, the USM NAP must utilize best practice teaching modalities for pharmacology in anesthesia to prepare SRNAs, so they are equipped to apply, analyze, synthesize, and evaluate drug information and how the information relates to the patient.

With the information gained from the literature review, a survey was created to seek student feedback about the courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II. Two different surveys, cohorts, and teaching platforms were utilized evaluating student perception of knowledge, application, and recommendations. The first survey was disseminated by USM to the cohort of nineteen USM SRNAs who graduated in December 2018. The first survey was based on a video-only format. The second survey was disseminated to the 2020 USM NAP cohort of twenty SRNAs at USM who were taught the same pharmacology courses utilizing video lecture, supplemental in-class discussion, and clinical scenarios in the simulation lab.

SRNA Survey Results

The 2018 and 2020 cohort surveys both consisted of eight questions with the only difference in the surveys being the teaching format. The 2018 cohort were asked questions that related to the video only delivery format. The 2020 cohort were asked questions related to the video instruction with supplemental in-class discussion and simulation delivery format. Both cohorts were given the opportunity to provide

comments for each question. The 2020 cohort survey was distributed using Quality Metrics, and student responses were anonymous.

Table A1.

2018 Cohort Survey Comments

Video Only Format
“Didn’t have to learn dosages”
“Consider adding pharm questions to lectures/anesthesia principle courses”
Unable to recall and apply “because it was taught almost a year before we start clinical”
“Blend of the delivery formats”
“Face to face lecture plus video and reading chapter may be helpful”
“Anything I would add would be a traditional lecture to review lectures covered from previous 3 weeks. I really like the video format and believed it was helpful and time-efficient.”
“I think a face to face learning along with some visual and auditory interaction would be better.”
“Pharm is the core of our profession. Face to face is better I think.”
“If video classes are kept, they should be supplemented with in-person lectures also”
“In class lecture after student reading assignment plus lecture to test application and dose/onset/DOA etc. Lab sim to learn what to expect with dose and vials concentration.”

Table A2.

2018 Cohort Survey Results

Questions	Yes	No
Did the Video Only delivery format enable you to learn and understand the pharmacological principles (such as pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) for the presented drugs?	7	6
Did the Video Only delivery format enable you to learn and understand the	6	7

Table A2 Continued recommended dosages for the presented drugs?		
Did the Video Only delivery format enable you to learn and understand the onset of times, duration of action, and half-lives for the presented drugs?	8	5
Did the Video Only delivery format enable you to recall and apply pharmacological principles (pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) effectively upon entering clinical education and in high-stress clinical situations?	4	9
Did the Video Only delivery format enable you to recall and apply dosage, onset times, duration of action, and half-lives effectively upon entering clinical education and in high-stress clinical situations?	3	10
Would a different course format enable you to learn and understand pharmacological principles, including dosage information, more effectively? Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of the delivery formats.	11	2

Table A2 Continued		
Would a different course format enable you to apply pharmacological principles, including dose information, more effectively upon entering clinical and in high-stress clinical situations? Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of delivery formats.	10	3

Table A3.

2020 Cohort Survey Comments

Video Instruction with Supplemental Discussion and Simulation
"I do think that it would have been better if we could have interacted via telecommunication with the instructor."
"The in-class activities helped to enhance video learning. It allowed for a hands-on approach."
"Utilizing notecards, hanging poster displays of drug information helped tremendously."
"The video lecture was very vague and contradictory on dosage recommendation."
"I think that the video supplies enough info but students themselves had to learn how to recall and apply to clinical."
"I still use my composition draw in book from time to time."
"Blended class format. As much as I hate coming to class, I'll pay attention more than just videos. Doing simulation helps you remember that situation so you can apply it later."
"I believe that the video instruction was adequate for the basic pharmacological principles of the various drugs, but the instruction lacked adequate information on dosing and real-world application. I believe that face-to-face traditional lecture with ability to ask questions in real-time would dramatically improve this course."
"A blend of methods would enhance learning."
"Face-to-face lecture with the ability to ask questions in real-time and the inclusion of real-world dosing vs. "book" dosing would be helpful. I also believe that clinical scenarios would help."
"The video format was good, but vasopressor drugs need to be looked at more. Please provide updated tables with drugs, safe dose range, etc. with references."

Table A4.

2020 Cohort Survey Results

Questions	Yes	No
Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to learn and understand the pharmacological principles (such as pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) for the presented drugs?	8	0
Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to learn and understand the recommended dosages for the presented drugs?	4	4
Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to learn and understand the onset of times, duration of action, and half-lives for the presented drugs?	4	4
Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to recall and apply pharmacological principles (pharmacodynamics, pharmacokinetics, mechanisms of action, and routes of elimination) effectively upon entering clinical education and in	7	1

Table A4 Continued high-stress clinical situations?		
Did the Video Instruction with Supplemental Discussion and Simulation delivery format enable you to recall and apply dosage, onset times, duration of action, and half-lives effectively upon entering clinical education and in high-stress clinical situations?	5	3
Would a different course format enable you to learn and understand pharmacological principles, including dosage information, more effectively? Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of the delivery formats.	7	1
Would a different course format enable you to apply pharmacological principles, including dose information, more effectively upon entering clinical and in high-stress clinical situations? Examples of course delivery formats include video only, face-to-face, traditional lecture, online, clinical simulation, or blend of delivery formats.	6	2

Review of Current Practices

After analyzing data that explore a variety of teaching modalities, the review of the literature supports utilizing a flipped classroom model for adult learners studying advanced pharmacology (Berrett, 2015). The flipped classroom, for our purposes, is comprised of independent study at home with video lectures along with weekly traditional classroom meetings with supplemental simulation. The video lectures can be watched at the students' own pace, allowing the student to review weak areas and take detailed notes in a provided workbook (M. J. Collins, personal communication, September 10, 2018). Weekly class meetings at USM allows students the opportunity to ask questions and/or facilitate discussion related to concepts in advanced pharmacology before taking written tests.

Recommendation

Practice Area: The University of Southern Mississippi Nurse Anesthesia Program

Subject: Advanced Pharmacology in Nurse Anesthesia

Title of Recommendation: Effective Teaching Modalities for Advanced Pharmacology in Nurse Anesthesia Programs

Based on both the review of literature and the data acquired through feedback from the 2018 and 2020 cohort surveys, a best practice recommendation was created representing the most effective teaching modality for the USM NAP advanced pharmacology courses.

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- Students from both 2018 and 2020 Cohorts agreed the pharmacology videos were helpful, but more teaching methods should be utilized in the pharmacology courses. Both cohorts recommended face-to-face time with instructor and time also being spent in the simulation lab. The 2020 Cohort specifically mentioned adjunctive teaching methodologies such as drug notecards and a poster display of drug information helped with retaining the pharmacological principles.
- Based on the available knowledge and student feedback, the flipped classroom setting is the recommended teaching format for nurse anesthesia advanced pharmacology courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II. The flipped classroom allows the student to learn independently from home, have face-to-face time in the classroom to discuss difficult topics and complete adjunctive methodologies, and time for simulation to apply pharmacological principles.

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APPENDIX G – Evaluation Tool

Expert Panel Evaluation Tool

1. The suggestions provided should be effective in teaching advanced pharmacology to SRNAs.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

2. The suggestions provided should aid SRNAs in their preparedness for the clinical setting.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

3. The best practice recommendation seems realistic for the USM NAP to adopt into the curriculum.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

4. The information provided was of high quality.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

5. Do you believe the proposed best practice recommendation will be of benefit to the USM NAP? (circle one)

   YES NO

6. If you selected "no" for question 5, please explain:

   _____

   _____

   _____

   _____

7. Please provide any suggestions for additions or critique.

   _____

APPENDIX H – Literature Matrix

Article Title	Date of Publication	Author(s)	Type of Evidence	Summary
General principles, pharmacodynamics, and drug-receptor concepts in nurse anesthesia	2014a	Nagelhout, J. J.	Book Chapter	In this book, the components associated with pharmacological principles are defined. Dr. Nagelhout relates the principles to anesthesia and providing care for different populations. Important pharmacological concepts the student registered nurse anesthesia must under are medication dosages, pharmacodynamics, pharmacokinetics, and many other essential drug parameters required to deliver anesthesia.
Pharmacy students' performance and perceptions in a flipped teaching pilot	2014	Wong, T. H., Ip, E. J., Lopes, I., & Rajagopalan, V.	Research Article	In this study, first-year pharmacy students were involved in a flipped classroom

on cardiac arrhythmias. American Journal of Pharmaceutical Education, 78(10)				teaching method. The focus of this study was cardiac arrhythmias. The students were supplied with prerecorded lectures to watch before attending class. The prerecorded lectures focused on 3-pilot areas which were basic sciences, pharmacology, and therapeutics. After watching the videos, students attended a class geared towards active- learning and case-based scenarios. Once students had participated in both portions of the class, a final examination was administered. The student's examination scores (intervention group) were

				compared to the Spring 2011 class (control group). Surveys were also implemented to get student feedback on the new method of teaching. Findings revealed an improvement in scores in the intervention group for two of the three pilot areas, pharmacology, and therapeutics. Along with the improvement of scores, students gave positive feedback on the surveys and student satisfaction was higher due to the new methods of teaching involving the quality of learning objective, prerecorded lectures, and in-class active

				learning activities.
Decision-making under pressure: medical errors in uncertain and dynamic environments. Australian Health Review, 42	2017, April 3	Zavala, A. M., Day, G. E., Plummer, D., & Bamford-Wade, A.	Research Article	In this research article, authors reviewed studies between 1980-2015 to determine the compounded factors associated with medical errors occurring in high-pressure environments. The authors also strived to determine the high-pressure environment impacts the clinician's ability to perform and the direct effect on patient outcomes. The environmental effects of clinician performance and patient outcomes can be complex and consist of a heavy workload, ineffective time management, the acuity of the case, and human factors.

The five-stage model of adult skill acquisition	2004	Dreyfus, S.E.	Journal Article	This article summarizes the model of adult skills acquisition that was developed by Stuart Dreyfus in collaboration with Hubert Dreyfus. According to the article, the adult progresses through five stages of performance: novice, advanced beginner, competent, proficient, and expert.

APPENDIX I – Executive Summary

Executive Summary of Effective Teaching Modalities in Nurse Anesthesia Pharmacology

Lane Bielstein and Jordan Eldridge

The University of Southern Mississippi

The Student Registered Nurse Anesthetists comprised a panel of experts to evaluate the conducted literature review and the collected evidence obtained from student surveys used to compose a best practice recommendation for teaching nurse anesthesia pharmacology. The presented information serves as the executive summary of the full report, “Effective Teaching Modalities in Nurse Anesthesia Pharmacology”, and will be printed and presented at The University of Southern Mississippi College of Nursing on September 27, 2019.

The best practice recommendation for teaching nurse anesthesia pharmacology is provided to help the SRNA with the ability to recall and apply pharmacological principles when entering the clinical setting. The purpose of this project was to determine students’ perception of nurse anesthesia pharmacology teaching methods, analyze evidence on effective teaching styles, and develop a best practice recommendation based on these findings.

Available Knowledge

When student registered nurse anesthetists (SRNAs) enter the clinical setting, clinical instructors and preceptors expect students to arrive prepared to recall and apply pharmacological concepts learned through their didactic coursework ("Nurse Anesthesia Program," 2019). Through this challenge, a question is raised: What is the most effective way to teach pharmacology to SRNAs so that knowledge can be effectively translated

into clinical practice? One challenge of nurse anesthesia education is relaying information so SRNAs are taught how to take their learning beyond test-taking and into implementing their knowledge of pharmacology during their anesthesia training. This process is necessary so SRNAs can safely anesthetize patients in a timely manner and under tense circumstances. Recall and application of pharmacological concepts is difficult in high-pressure, real-world settings for nurse anesthesia students new to clinical practice (Crouzevialle, Smeding, & Butera, 2015).

The first component investigated was the pharmacology knowledge the SRNA is required recall and apply in the clinical setting. Important pharmacological concepts include medication dosages, pharmacodynamics, and pharmacokinetics. The SRNA cannot rely on these principles alone when in the clinical setting. Other pertinent factors are the patient's age and body habitus and how these factors affect intravenous drug administration as well as inhalational anesthetics. Identification of necessary pharmacological principles is important to this project for the anesthesia provider to be successful in the clinical setting and to provide a safe anesthetic to patients undergoing surgical procedures (Nagelhout, 2014a).

The second component investigated was high-pressure performance. The SRNA must recall and apply the acquired pharmacological knowledge in high-pressure settings such as the clinical environment. Studies were focused on the clinical decision-making process when providers were under high-pressure. Five components were commonly found during which were, organizational systems, workload, time pressure, individual human factors, and case complexity. Each component can affect the provider's ability to

respond efficiently in an emergent or high-pressure environment (Zavala, Day, Plummer, & Bamford-Wade, 2017).

The third component investigated was the stress of new students in clinical health professions. Stress in the setting of learning is fundamental to the progressive motivation of students. However, stress that extends beyond a moderate level can lead to negative consequences. A 2011 researcher, Savtchouk, revealed that even a small experience with acute stress can adversely affect the health of the student. Different stressors affecting the SRNA are academic, clinical, and external factors such as finances. At one end of the scale, a student under stress may produce a favorable experience, supporting focus, and at the other end of the scale, the student may have a detrimental response (McKay et al., 2010).

The fourth component investigated was adult pedagogy. Bloom's Taxonomy model consists of six major categories: knowledge, comprehension, application, analysis, synthesis, and evaluation. A deficit identified by clinical preceptors associated with the USM NAP, also known as adjunct faculty, is a weakness in the knowledge base of SRNAs in advanced pharmacology and their ability to recall and apply pharmacological principles in the clinical environment (M. J. Collins, personal communication, September 10, 2018). Thus, a prediction is made that though SRNAs have the knowledge and comprehension skills to score well on written tests, they may not be advanced enough in their educational progression to be able to successfully apply, analyze, synthesize, and evaluate necessary pharmacological concepts to put their newly acquired knowledge into practice.

Different models of teaching were explored with the focus being on the flipped classroom teaching method. The flipped classroom implements interactive forms of teaching and has been shown to improve the retention of educational material and aid in skills needed for the clinical setting. Even though the flipped classroom teaching method involves the traditional face to face lecture meetings, the flipped classroom utilizes more forms of teaching such as online lectures and simulation and in some instances has yielded higher test results than the traditional classroom setting. The flipped classroom involves reversing the conventional role of students and faculty members ("A Guide to the Flipped Classroom", 2015).

Process

A survey was created based on the survey disseminated by USM to the cohort of nineteen USM SRNAs who graduated in December 2018 from the NAP. The format of this survey was based on pharmacology taught through a video-only format. An intervention was made by creating a new survey and disseminating the survey to the 2020 cohort of twenty SRNAs in the NAP at USM who were taught courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II using videos, supplemental discussion, and simulation. The key differences between the 2018 Cohort Survey and the 2020 Cohort Survey were the teaching methods.

Once data from both surveys were gathered and analyzed, a review of findings was created along with a best practice recommendation and distributed to a panel of experts. The panel of expert members were composed of a faculty representative, a pharmacology education representative, a health policy expert, a clinical preceptor, and a clinical coordinator. Member of the panel completed an anonymous survey evaluating the

data and the project. Three out of the four members who completed the survey believed the project to be of high quality with one member neither agreeing nor disagreeing. The four panels members agreed the proposed best practice recommendation would be effective in teaching advanced nurse anesthesia pharmacology, would aid SRNAs in their preparedness for clinical, and would benefit the USM NAP.

Best Practice Recommendation

Practice Area: The University of Southern Mississippi Nurse Anesthesia Program

Subject: Advanced Pharmacology in Nurse Anesthesia

Title of Recommendation: Effective Teaching Modalities for Advanced Pharmacology in Nurse Anesthesia Programs

Based on both review of the literature and the data acquired through feedback from the 2018 and 2020 cohort surveys, a best practice recommendation was created representing the most effective teaching modality for the USM NAP advanced pharmacology courses.

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notecards and a poster display of drug information helped with retaining the pharmacological principles.

- Based on the available knowledge and student feedback, the flipped classroom setting is the recommended teaching format for nurse anesthesia advanced pharmacology courses NUR 832: Advanced Pharmacology for Anesthesia I and NUR 833: Advanced Pharmacology for Anesthesia II. The flipped classroom allows student to learn independently from home, have face-to-face time in the classroom to discuss difficult topics and complete adjunctive methodologies, and time for simulation to apply pharmacological principles.

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APPENDIX J – DNP Essentials

Doctor of Nursing Practice Essentials	How the Essential is Completed
I. Scientific Underpinnings for Practice	Essential one was completed by reviewing relevant evidence conducted on the topic.
II. Organizational and Systems Leadership for Quality Improvement and Systems Thinking	This project's goal was to determine if the most effective methods for teaching nurse anesthesia pharmacology.
III. Clinical Scholarship and Analytical Methods for Evidence-Based Practice	In order to determine the most effective methods of teaching nurse anesthesia pharmacology, an extensive literature review was conducted reviewing teaching methods such as flipped classrooms and the use of high-fidelity simulation.
IV. Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care	High-fidelity simulation is a teaching method for nurse anesthesia pharmacology discussed in this paper. Incorporating simulation has the potential to increase the SRNA's confidence when entering the clinical setting.
V. Health Care Policy for Advocacy in Health Care	A best practice recommendation for the most effective teaching methods of nurse anesthesia pharmacology will be presented to a panel of experts.
VI. Inter-professional Collaboration for Improving Patient and Population Health Outcomes	The use of pharmacology simulation allows the SRNA the ability to act as the clinician and collaborate with healthcare team members that may be present in the operating room.
VII. ClPrevention and Population Health for Improving the Nation's Health	Utilizing the most effective teaching methods of nurse anesthesia pharmacology can help prepare the SRNA for the clinical setting and the high-pressure situations that may occur.
VIII. Advanced Nursing Practice	By incorporating simulation into nurse anesthesia pharmacology, the DNP prepared SRNA can practice assessment skills and practice acknowledgment of psychological, behavioral, cultural, and economic influences before entering the operating room.

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